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Reed

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[45] **Date of Patent: Feb. 14, 1989**

[54] **OIL AND GAS WELL DIVERSIONARY SPOOL ASSEMBLY**

[76] Inventor: **Lehman T. Reed,** 3219 Candlewood Dr., Bakersfield, Calif. 93306

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[51] **Int. Cl.**[4] **E21B 33/03;** E21B 34/02

[52] **U.S. Cl.** **166/65.1;** 166/76; 166/97.5; 166/313; 166/379

[58] **Field of Search** 166/65.1, 67, 70, 75.1, 166/76, 79, 97.5, 313, 377, 378, 379, 82

[56] **References Cited**

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Primary Examiner—Jerome Massie
Assistant Examiner—Terry Lee Melius
Attorney, Agent, or Firm—William C. Babcock

[57] **ABSTRACT**

A diversionary spool assembly for the completion hook up of any type of oil and gas well without the use of an expensive and cumbersome valve tree as a permanent part of the producing well. A single valve tree is provided, and is removably mounted on any one of a group of wells provided with diversionary spool assemblies only when a particular well in that group requires maintenance or remedial work to be performed thereon.

Each diversionary spool assembly includes a rigid body having at least first and second passages therein, which body is operatively mounted on a tubing hanger supporting casing head for the first passage to be vertically aligned with a vertical bore in the tubing hanger and a tubing string that depends from the latter.

The first passage in the normal operation of the well has a plug removably and sealingly disposed therein. A bonnet is removably secured to the body by bolts, which bolts are also capable of removably securing the anchor flange of a valve tree to the body to permit maintenance and remedial work to be performed on the well when the plug is removed from the first passage. When the remedial and maintenance work has been completed, the valve tree is removed from the body, the plug inserted in the first passage, the bonnet secured to the body, and the well returned to production.

15 Claims, 5 Drawing Sheets

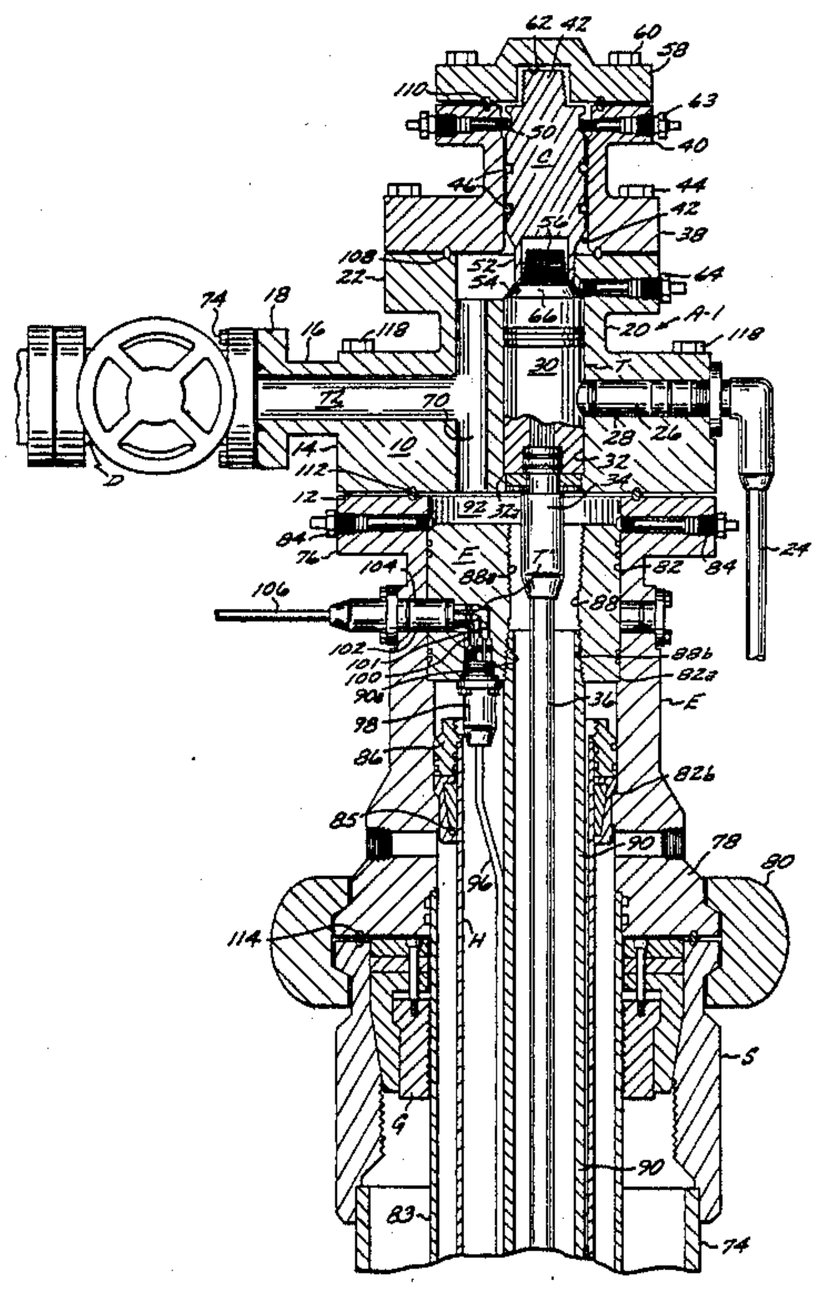
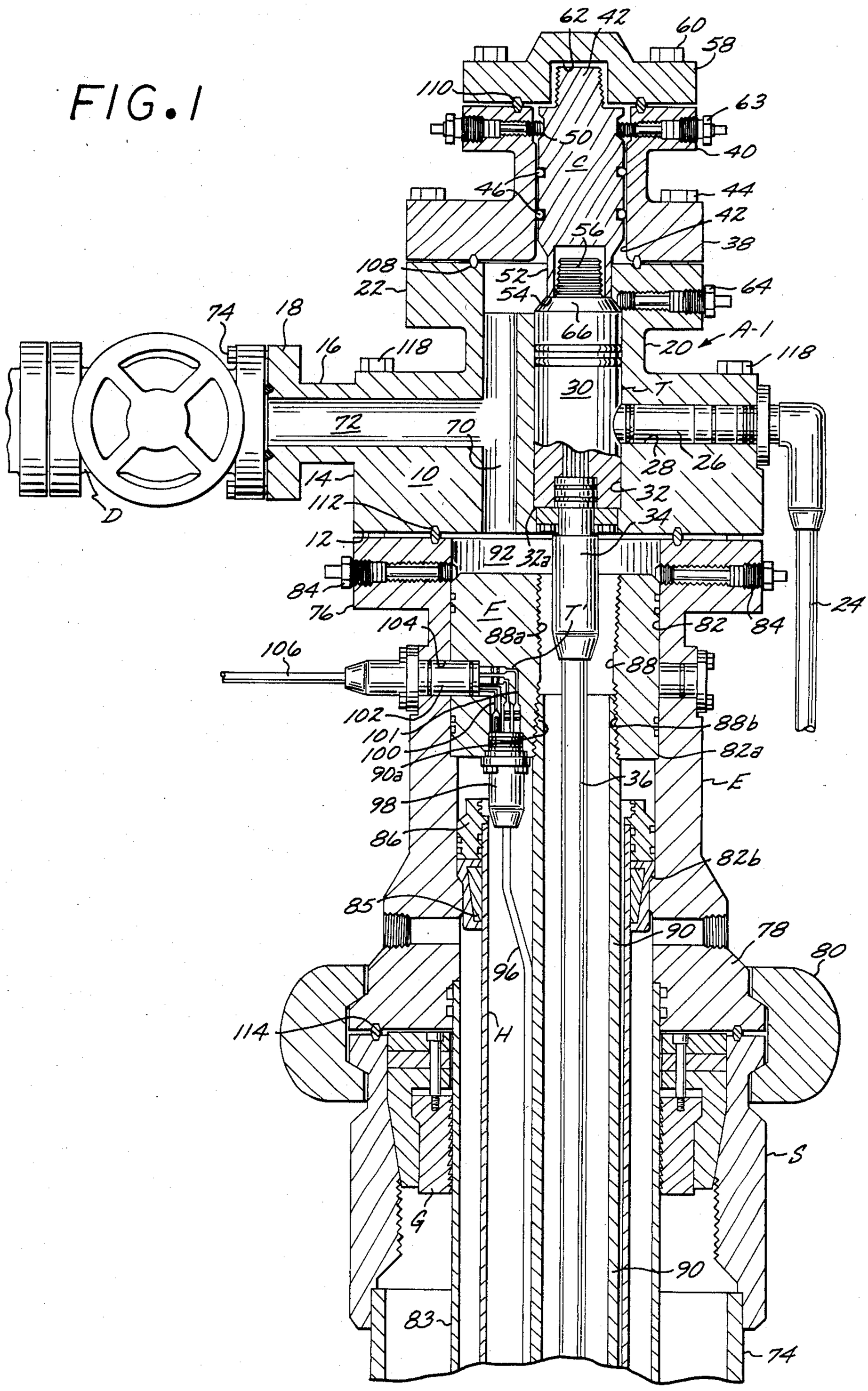


FIG. 1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66
A-1
20
16
118
118
30
T
72
70
28
26
14
10
32
112
34
12
92
37a
84
76
F
T'
104
88a
82
84
24
106
88
102
88b
101
82a
100
90a
36
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98
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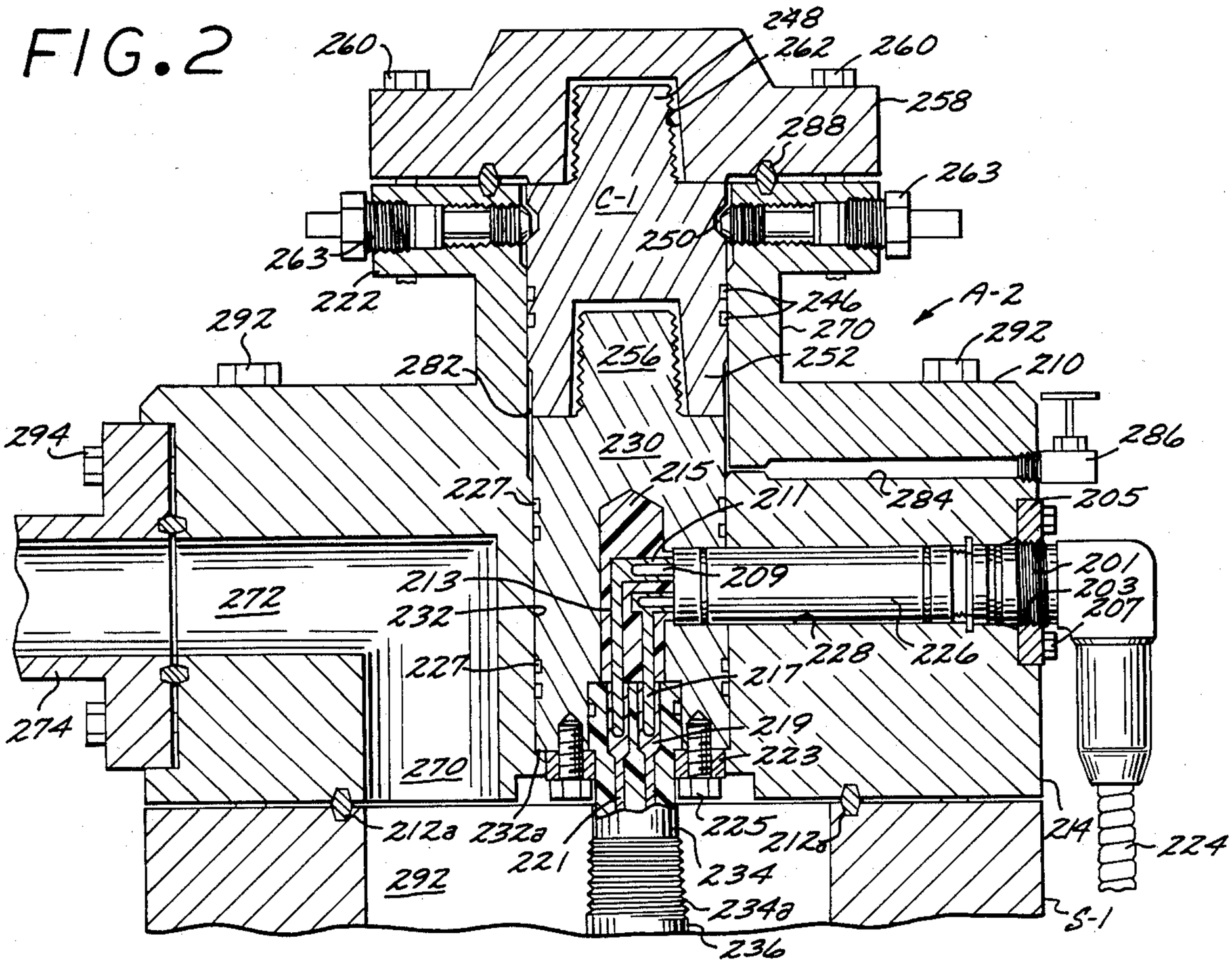
82b
85
90
78
80
96
114
H
S
G
90
83
74

FIG. 2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260
262
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288
263
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263
250
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A-2
292
270
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256
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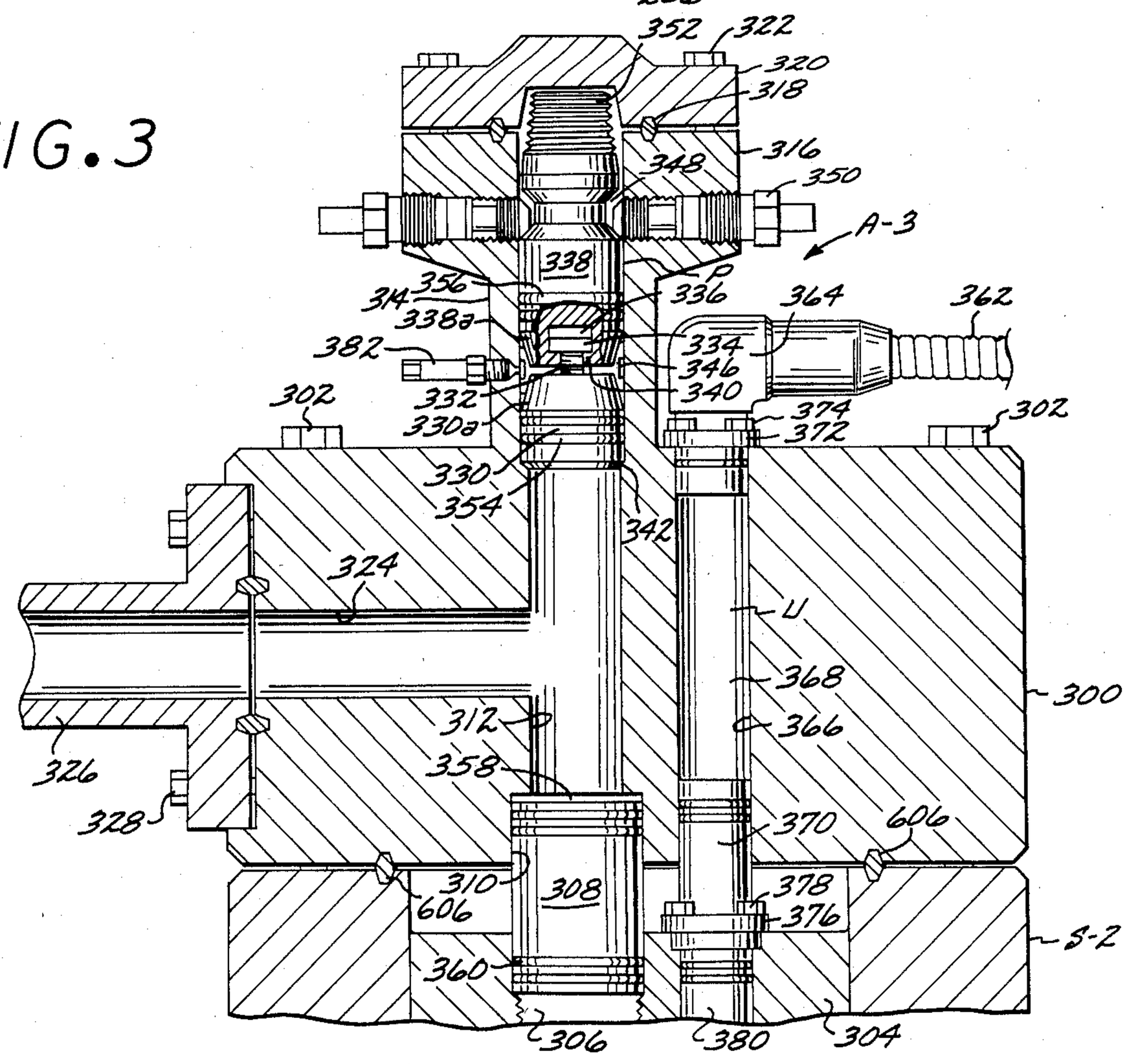
294
286
230
215
227
211
284
205
209
201
213
203
272
232
207
228
226
227
217
274
219
223
270
212a
232a
221
225
212a
214
224
234
292
234a
S-1
236

FIG. 3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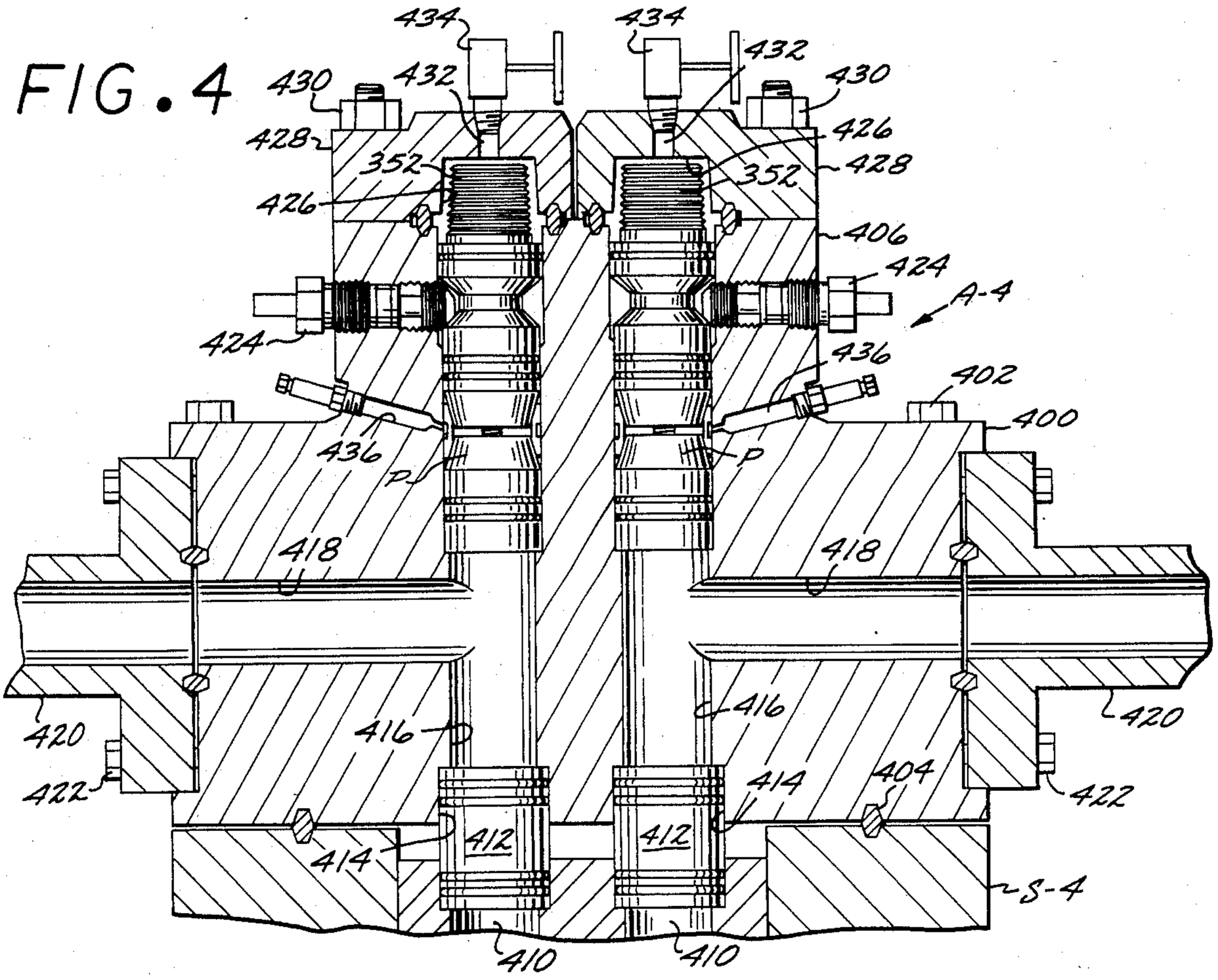
332
374
302
330a
372
302
330
354
342
324
U
368
300
312
366
358
326
370
606
328
310
308
378
606
376
S-2
360
306
380
304

FIG. 4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400
P
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412
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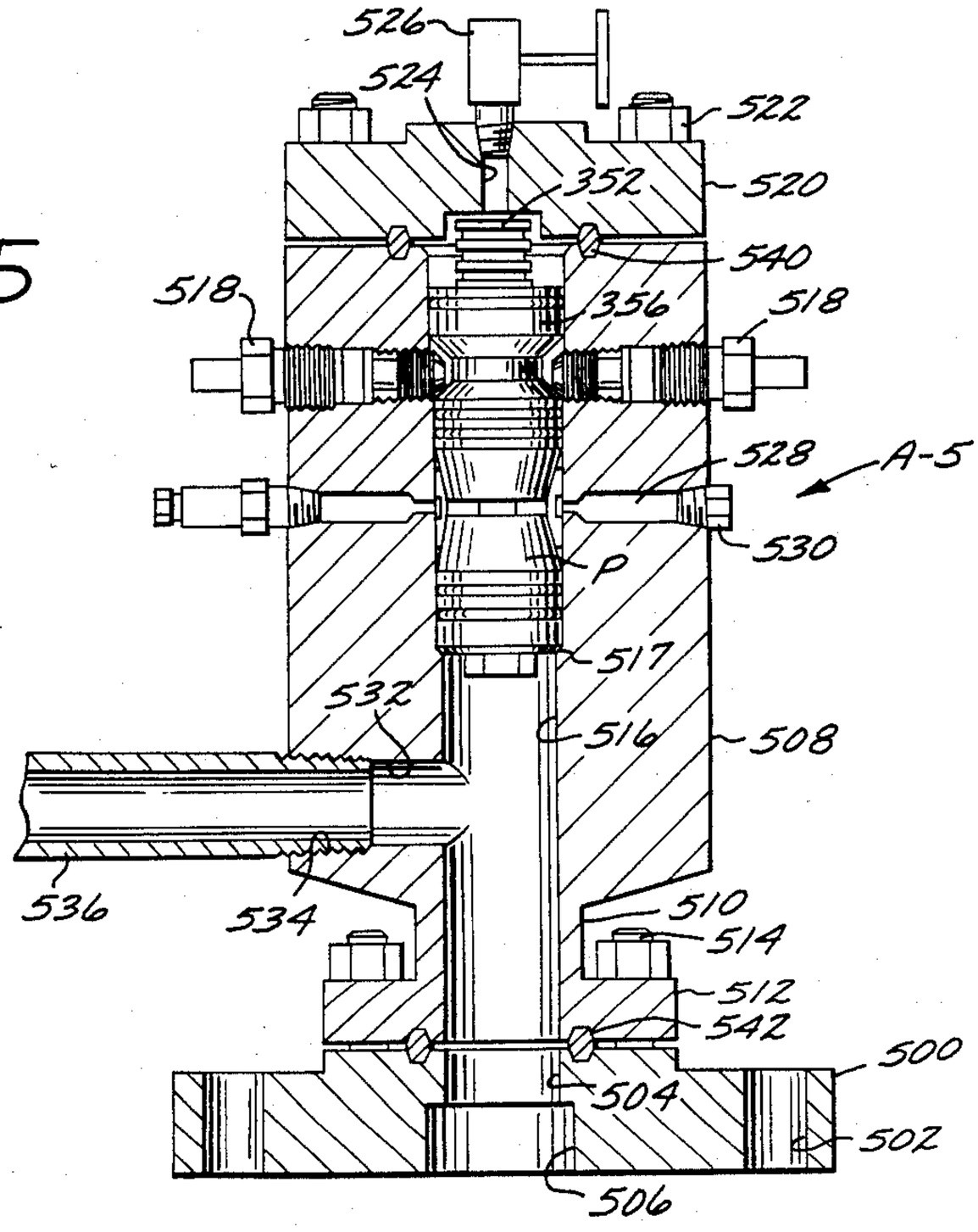
S-4
410
410

FIG. 5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A-5
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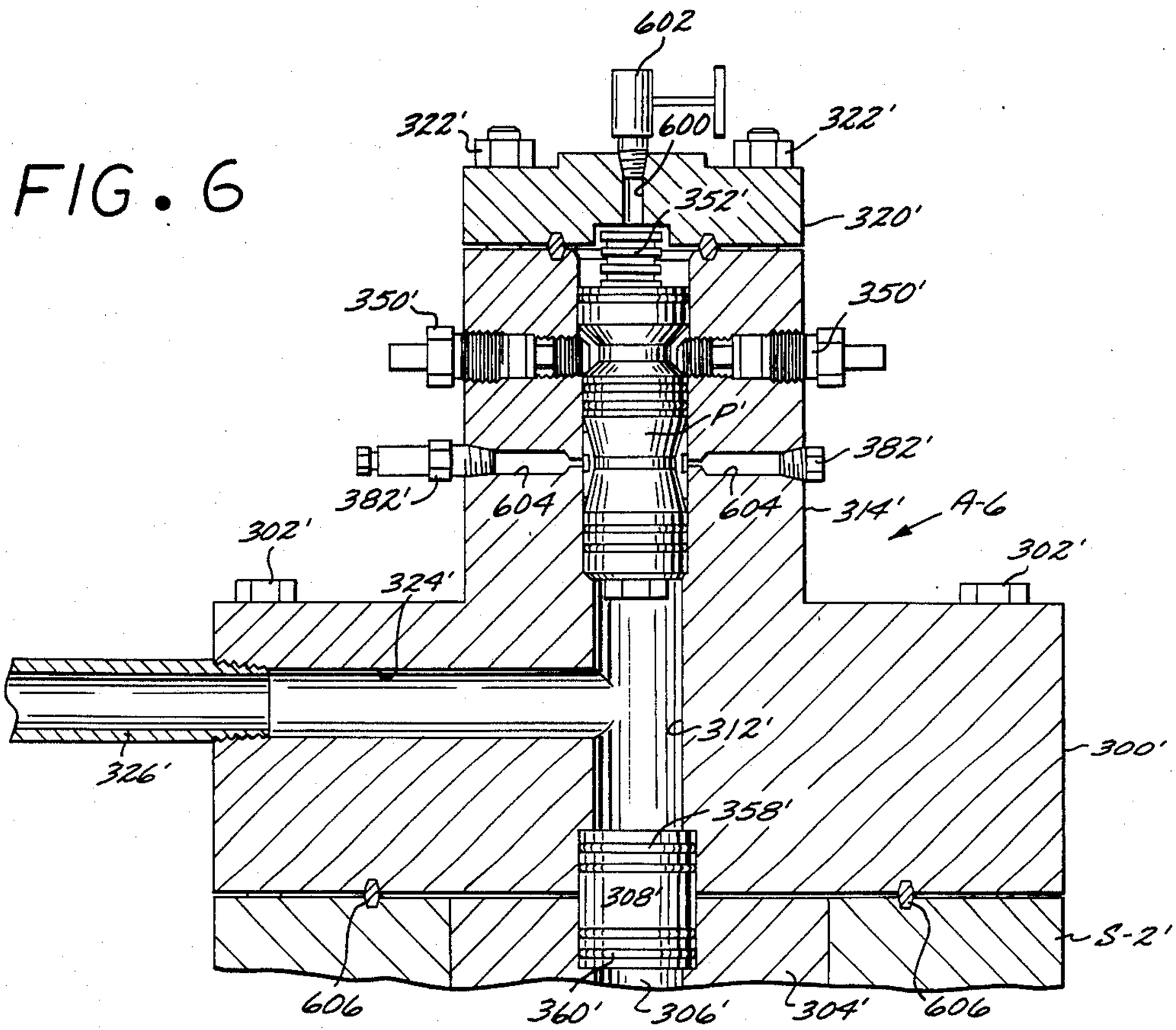
512
542
500
504
502
506

FIG. 6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322'
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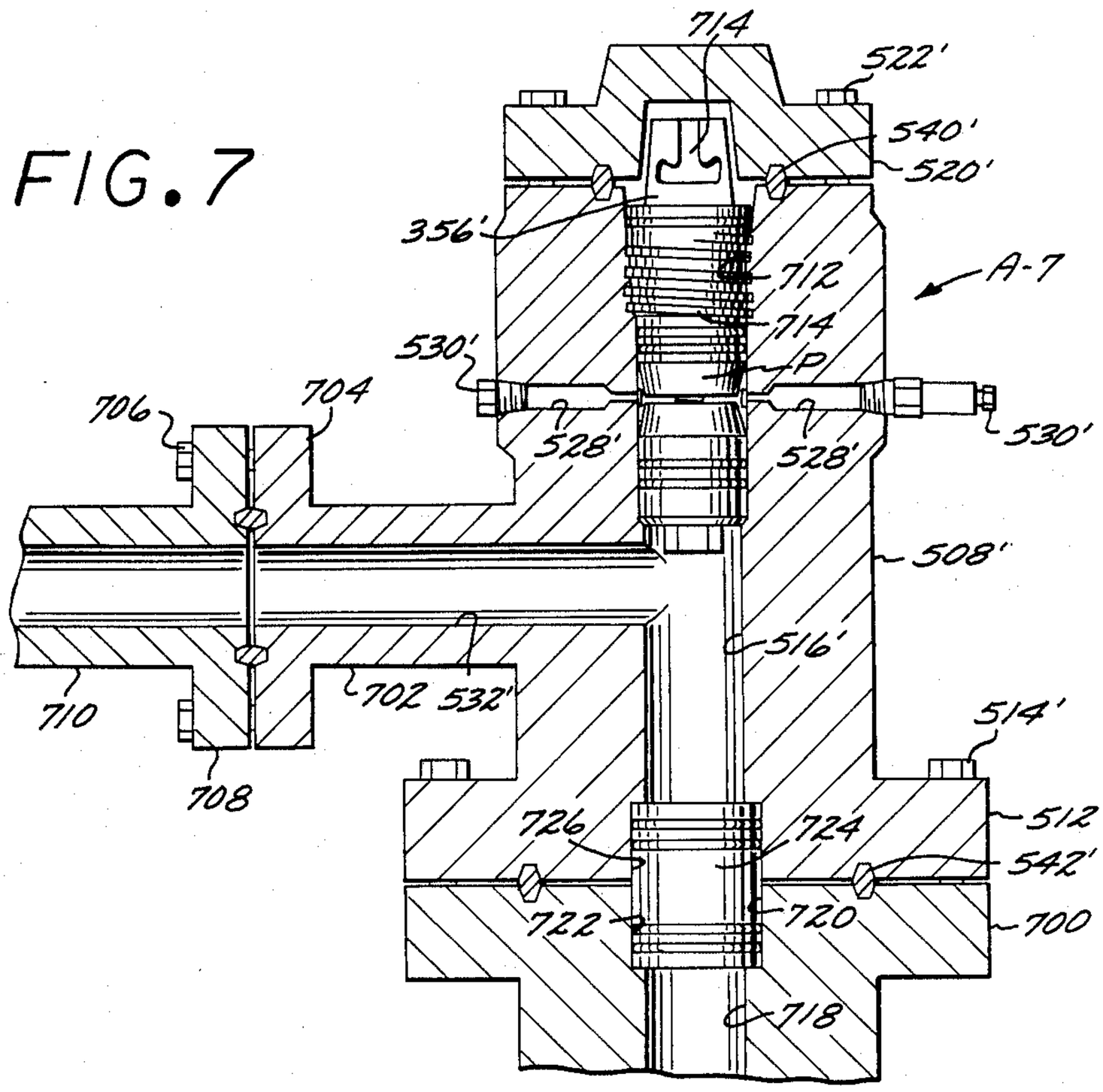
P'
382'
382'
604
604
314'
A-6
302'
324'
302'
312'
326'
300'
358'
308'
S-2'
606
360'
306'
304'
606

FIG. 7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708
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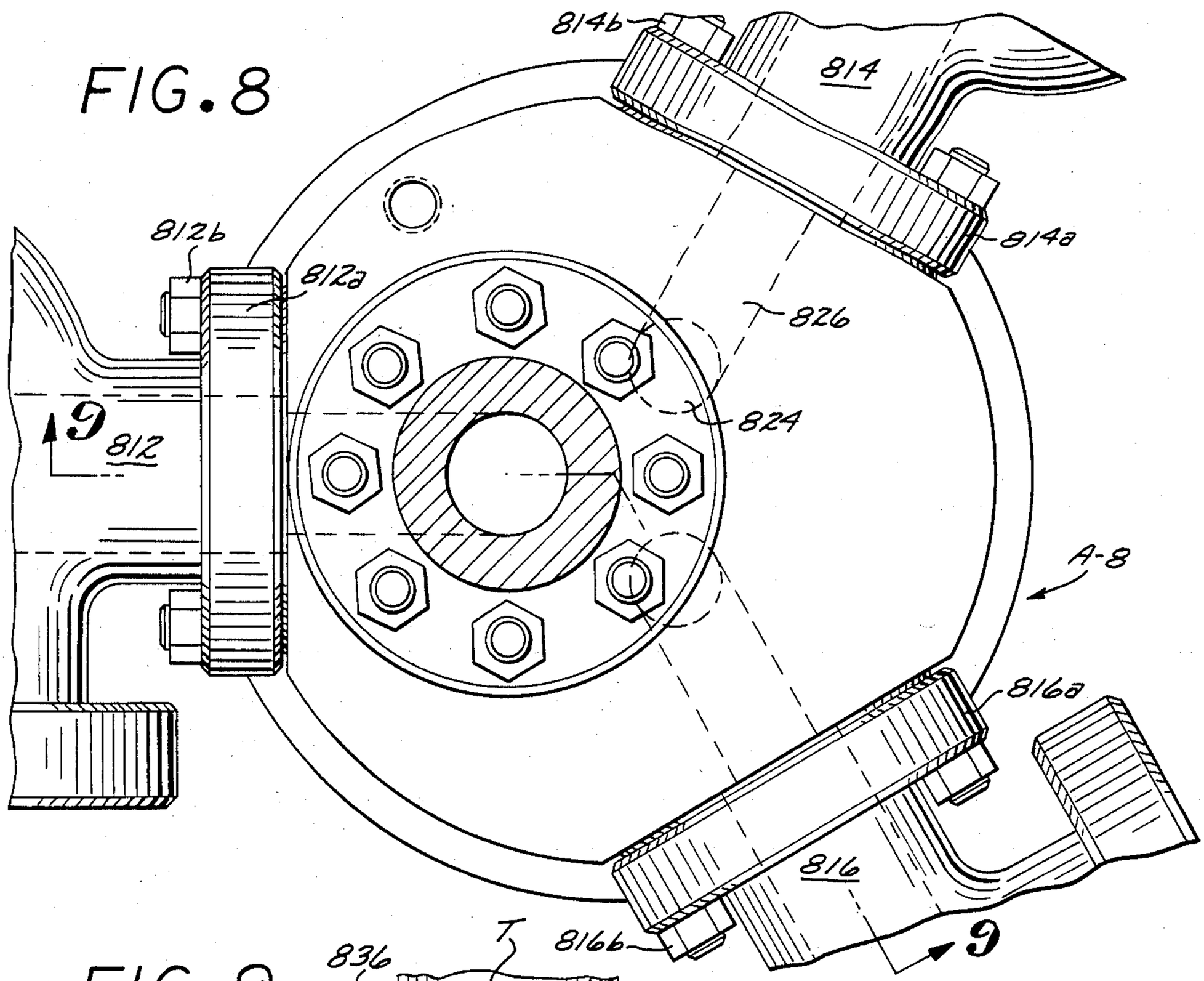
542'
722
720
700
718

FIG. 8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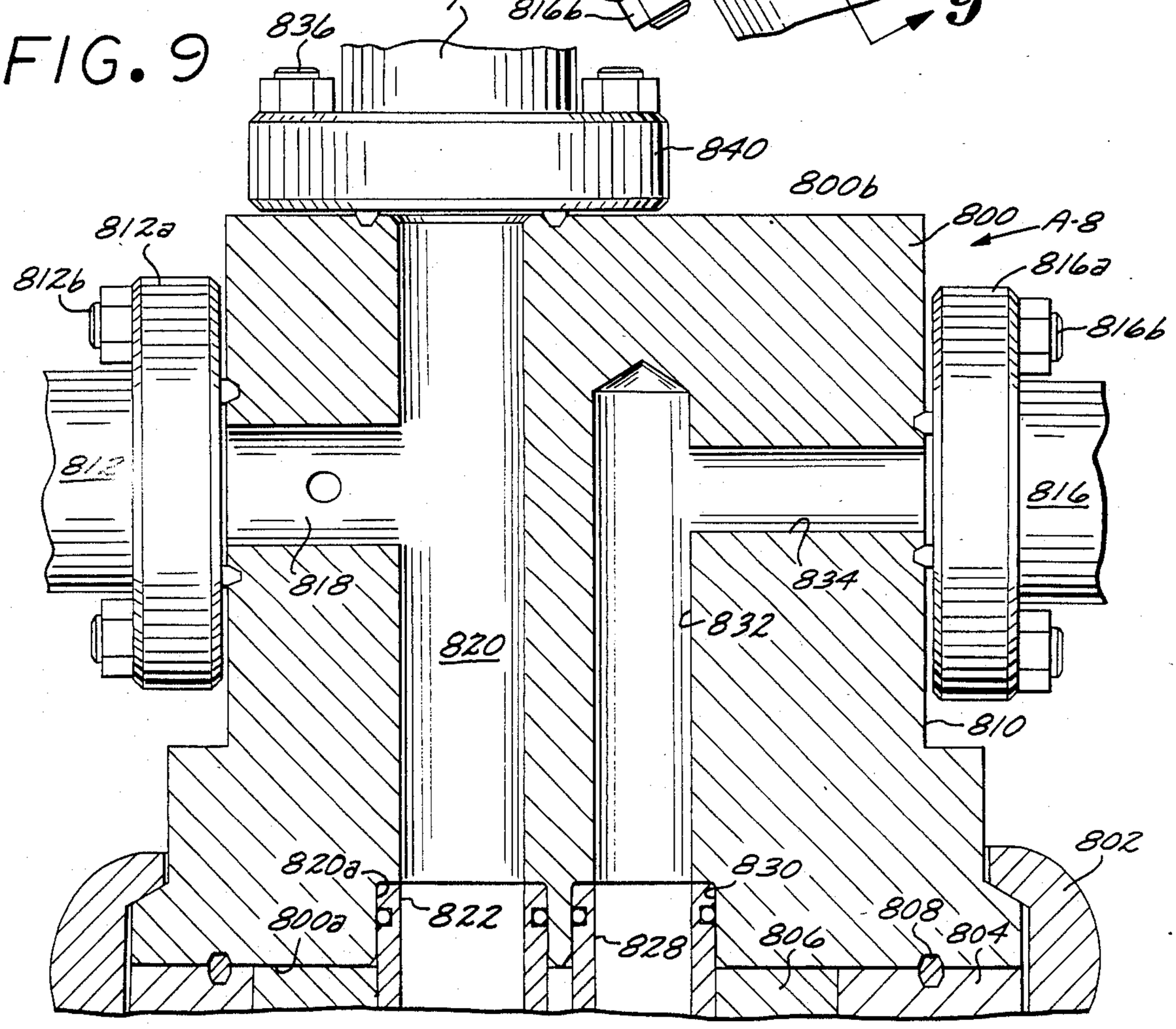
812a
826
824
9
812
A-8
816a
816
816b
9

FIG. 9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830
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808
804
806
802
800a

OIL AND GAS WELL DIVERSIONARY SPOOL ASSEMBLY

REFERENCE TO RELATED APPLICATIONS

Application Ser. No. 666,291 filed Oct. 29, 1984 entitled "Top Entry Electrical Transmission Assembly for Submersible Pumps".

BACKGROUND OF THE INVENTION

In the past the completition hook-up of an oil and gas well involved a tree array of valves being operatively mounted on the well head to not only control the operation of the well in a safe manner but to permit remedial work to be performed on the well when the occassion so required. Tree array of valves referred to as 'christmans tree' in the oil fields are not only complicated, cumbersome and expensive, but due to corrosion may deteriorate to the point that they have to be replaced prior to the termination of the production lives of the wells with which they are associated.

A primary object of the present invention is to provide a diversionary spool assembly that is operatively associated with the casing head of an oil and gas well to control the production of fluid therefrom, and without the use of a christmas tree array of valves, all at a substantial saving to the operator of the well.

Another object of the invention is to not only provide a diversionary spool assembly having not only the above mentioned operational advantages, but one that is adapted when the occassion so requires to have a christmas tree array of valves removably secured thereto to permit remedial work to be performed on the well.

A still further object of the invention is to furnish a diversionary spool assembly of such design and structure that when each well in a group thereof is provided with one, a single working christmas tree may be secured to any desired one of the diversionary spools to permit maintenance work to be performed on the well associated therewith, with the working christmas tree being separated from the well after the maintenance work is performed.

These and other objects and advantages of the invention will become apparent from the following description thereof and the drawings illustrating the same.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a vertical cross sectional view of a first form of diversionary spool assembly mounted on a unitized well head which in turn is secured to a casing head of a well, and is capable of supplying electric power and pressurized fluids for down hole purposes;

FIG. **2** is a vertical cross sectional view of a second form of diversionary spool assembly capable of supplying electric power for downhole purposes;

FIG. **3** is a vertical cross sectional view of a third form of diversionary spool assembly that serves the same function as the second form of the invention;

FIG. **4** is a vertical cross sectional view of a fourth form of diversionary spool assembly for use on either a dual injection or dual production well;

FIG. **5** is a vertical cross sectional view of a fifth form of diversionary spool assembly for use on an artesian well;

FIGS. **6** and **7** are vertical cross sectional views of sixth and seventh forms of diversionary spool assemblies for use on artesian wells;

FIG. **8** is a top plan view of an eighth form of diversionary spool assembly for use on a hydraulically operated well;and

FIG. **9** is a vertical cross sectional view of the invention shown in FIG. **8** taken on line **9-9** of the latter.

SUMMARY OF THE INVENTION

The invention as illustrated in FIGS. **1** to **3** is a diversionary spool assembly that is so operatively connected to a well head that fluid pumped upwardly through a tubing string by a submersible pump may be controlled by a valved outlet, and the diversionary spool assembly also capable of supplying electrical communication between an electric power supplying cable disposed exteriorly of the assembly and an electric power receiving cable that extends downwardly in the bore hole of the well and is also capable of supplying pressurized fluids for down hole purposes. The diversionary spool assembly when the occasion so requires is capable of having a christmans tree array of valves removably secured thereto for maintenance and remedial work to be performed on the well.

The invention as illustrated in FIGS. **4** to **7** is a diversionary spool assembly that is operatively connected to the casing head of a flowing well to not only control the rate of fluid flow from the well, but to permit a christmas tree array of valves to be removably mounted on the well to permit remedial and maintenance work to be performed on the latter when the occassion so requires.

The invention as shown in Figs.**8** and **9** is a diversionary spool assembly that has the operational advantages previously mentioned, and is adapted for use on a hydraulically operated well.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A first form A-**1** of the diversionary spool assembly is shown in FIG. **1** that is illustrated as being defined by a generally cylindrical rigid body **10** that has a flat lower surface **12**, sidewall **14**, a laterally extending tubular neck **16** for production fluid discharge and that terminates in a flange **18**, and an upwardly extending tubular neck **20** that has a flange **22** on the upper end thereof.

An electrical power supply cable **24** is connected to a first electrical conducting cartridge **26** that is removably and sealing disposed in a lateral passage **28** in body **10** and in removable electrical communication with a second electrical conducting cartridge **30**. The second cartridge **30** is removably supported in a vertical first passage **32** in body **10**, and removably connected to an electrtical conducting connector **34** from which an electic power receiving cable **36** extends downwardly to an electrically driven submersible pump of a type that is commercially available (not shown) and that may be supported in the bore hole by the cable.

The first and second cartridges **26** and **30** and connector **34** provide an electrical conducting assembly T that is of the structure described and illustrated in detail in my U.S. Pat. No. 4,491,176 entitled "Power Supplying Well Head Assembly" that issued on Jan. 1, 1985.

A plug supporting spool B includes a lower flange **38** and upper flange **40**, with a vertically extending passage **42** being formed in the spool that is in vertical alignment with the first passage **32** as may be seen in FIG. **1**. Lower flange **38** is removably secured to flange **22** by bolts **44**. A plug C having circumferentially sealing rings **46** thereon is removably supported in passage **42**.

Plug C includes an upwardly disposed threaded extension **48**, a recessed side portion **50**, and a tubular shell **52** that bears against a portion **54** of second cartridge **30**. Second cartridge **30** includes an upwardly projecting threaded extension **56**.

Upper flange **40** has a bonnet **58** removably secured thereto by bolts **60**. Bonnet **58** has an upwardly extending cavity **62** into which threaded extension **48** projects. Upper flange **40** supports screws **63** that bear against recessed portion **50** to prevent upward movement of plug C. Flange **22** supports screws **64** that bear against a tapered portion **66** of second cartridge **30**, and that serve to force second cartridge **30** into sealing contact with a shoulder **32***a* in passage **32** as shown in FIG. **1**.

Body **10** has a vertically extending, fluid conducting passage **70** therein that communicates with a lateral passage **72** in neck **16**. A flanged fluid control valve D is removably mounted on flange **18** by bolts **74**.

The diversionary spool assembly A-**1** is illustrated in FIG. **1** as secured to the upper end of a unitized well head E that in turn is mounted on a casing head S secured to the upper end of a surface string of casing **74**. Unitized well head E is of tubular shape and includes an upper ring shaped flange **76** and a lower flange **78** that by clamp means **80** is secured to the upper end of casing head S.

Well head E has a vertically extending passage **82** therein in which upper and lower body shoulders **82***a* and **82***b* are defined. A generally cylindrical tubing hanger F is removably disposed in passage **82** and rests on upper body shoulder **82***a*. Screws **84** are rotatably supported by upper flange **76** and removably engage tubing hanger F to prevent undesired upward movement thereof .An intermediate casing string **83** has the upper end portion landed in a conventional slip assembly G supported in casing head S.

An inner string of casing H extends downwardly to the production zone(not shown) and has the upper end landed in a slip assembly **85** supported on body shoulder **82***b*. A sealing ring assembly **86** is in sealing engagement with a surface portion of well head E that defines passage **82** and the outer surface of casing H.

Tubing hanger F has a vertically extending bore **88** therein that has upper and lower threaded portions **88***a* and **88***b*. Lower threaded portion **88***b* engages and supports a threaded end portion **90***a* of a downwardly extending tubing string **90** that on the lower end is in fluid communication with an electric powered submersible pump (not shown). Fluid discharge from the pump flows upwardly through tubing **90**, passage **88**, a space **92** between tubing hanger F and body **10**, and passages **70** and **72** to valve D which may be manipulated to control the rate of fluid flow.

Pressurized fluids and auxillary electric power to operate down hole equipment (not shown) may be supplied to a concuit **96** that extends downwardly in the well from a connector **98** that is removably secured to a second cartridge **100** that in turn is in removable engagement with a first cartridge **102** mounted in a transverse bore **104** in well head E.

Pressurized fluids and auxillary electric power is supplied to first cartridge **104** by a conduit **106** that contains pressurized fluid conducting lines and an auxillary electric power line (not shown). A portion of the conductors in first cartridge **102**, second cartridge **100**, and connectore **98** are hollow to permit pressurized fluid flow from conduit **106** to conduit **96**. First cartridge **102**, second cartridge **100** and connector **98** comprise an assembly T' that is of the same structure as assembly T, other than that a portion of the conductors designated **101** are hollow.

A sealing ring **108** is disposed between flanges **30** and **22**, and a sealing ring **110** is situated between bonnet **58** and flange **40**. Flange **14** and flange **76** have a sealing ring **112** disposed therebetween. Also, flange **78** and casing head S have a sealing ring **114** disposed therebetween.

The flange **40** and the spacing of the bolts **60** is such that when the bonnet **58** is removed, the anchor flange of a conventional present day christmas tree array of valves (not shown) may be secured to flange **40** by use of the bolts **60**.

After the bonnet **58** is removed from flange **40**, and after the christmas tree array of valves (not shown) is secured thereto, the screws **62** are loosened and the threaded extension **48** of plug C is engaged by a suitable tool (not shown). Plug C may now be lifted upwardly and outwardly from spool B. Prior to the removal of the bonnet **58** the flow of electric power to the submersible pump (not shown) is terminated.

The next step is to move the first cartridge **26** outwardly out of engagement with the second cartridge **30**. The threaded extension **56** of second cartridge **30** may now be engaged by a suitable tool (not shown)to move the second cartridge **30**, connector **34**, cable **36**, and the submersible pump (not shown) upwardly and out of the diversionary spool assembly A-**1**. The christman tree array of valves (not shown) may now have the anchor flange thereof (not shown) removabvly secured to flange **40** by the bolts **60** to permit remedial and maintenance work to be performed on the well.

Should it be desired to remove the tubing hanger F and tubing string **90** from the well, the bolts **118** and **74** are loosened to permit separation of diversionary spool assembly A-**1** from well head E, and flanges **18** and **74** from one another.First cartridge **102** is now moved outwardly from engagement with second cartridge **100**. Threaded portion **88***a* of bore **88** is engaged by a suitable threaded tool (not shown) and the tubing hanger F and desired portion of tubing string **90** lifted upwardly above the well head E. When the desired maintenance work has been performed, the above described operation is reversed and the well returned to production.

From the above description it will be seen that when each of the wells in a group thereof is equiped with a diversionary spool assembly A-**1**, only a single working christmas tree array of valves is required to permit maintenance to be performed on the wells, all at a great financial saving to the operator the wells, as the diversionary spool assemblies A-**1** are far less expensive than the conventional christmas tree array of valves previously provided on the wells.

A diversionary spool assembly A-**2** is shown in FIG. **2** that has the same operational advantages as the diversionary spool assembly A-**1**, but is secured directly to a casing head S-**1** that supports a tubing hanger(not shown) of the same general structure as the tubing hanger F illustrated in FIG. **1**. The diversionary spool assembly A-**2** includes a generally cylindrical body **210** that has a flat lower surface **212** and a side wall **214**, as well as an upwardly extending tubular neck **220**. The tubular neck **220** develops on the upper end thereof into a flange **222** that is a companion flange to the anchor flange (not shown) of a conventional present day christmas tree array of valves.

An electric power supply cable **224** is connected to a first electrical conducting cartridge **226** that is slidably and sealingly mounted in a lateral passage **228** defined in body **210**. First electrical conducting cartridge **226** is in removable and electical engagement with a second electrical conducting cartridge **230**.

Second cartridge **230** is slidably and removably mounted in a vertical first passage **232** that has a shoulder **232***a* that acts as a stop for the lower portion of the second cartridge.

An electrical conducting connector **234** removably engages the lower portion of the second cartridge **230**. Connector **234** supports an electric power supplying cable **236** that extends downwardly in the well to engage an electrically operated submersible pump (not shown) or for any other desired purpose.

First cartridge **226** has threads **201** thereon that are engaged by a threaded bore **203** in a plate **205** that is removably secured to body **210** by bolts **207**. First cartridge **226** has electrical conducting prongs **209** on the inner end thereof that removably engage electrical conducting sockets **211** secured to electrical conductors **213**, which conductors are supported in a core of electrical insulating material in second cartridge **230**.

Electrical conductors **213** on their lower end portions define downwardly extending prongs **217** that removably and slidably engage the electrical conducting sockets **219** connected to electrical conducting conductors **221** that extend downwardly through cable **236**. A ring shaped plate **223** engages a shouldered portion of second cartridge **230**. Bolts **225** extend through plate **223** and serve to removably hold plate **223** in a supporting position for a connector **234**.

Sealing rings **227** are mounted on second cartridge **230** above and below first cartridge **226** and are in pressure contact with the portion of body **210** that defines first passage **232**. Cable **236** extends downwardly through a tubing hanger(not shown),and a tubing string (not shown) in the same manner as the cable **36** does and as as illustrated in FIG. **1**. Fluid discharges upwardly in the well to enter a space **292** that is comparable to space **92** previously described ,and then enters second passages **270** and **272** to exit through a control valve **274**.

Second cartridge **230** has an upwardly extending threaded projection **256** which may be removably engaged by a suitable tool (not shown) as will later be explained.

A plug C-**1** provided with external circumferentially extending sealing rings **246** is slidably mounted in first passage **232** and seals with the surface portion of body **210** defining the passage. Plug C-**1** has an upper externally threaded portion **248** that may be removably engaged by a suitable tool (not shown) to lift the plug C-**1** from the passage **232**. Plug C-**1** includes a recessed upper side portion **250** and a tubular shell **252** that extends downwardly into abutting contact with second cartridge **250**. Extension **256** projects upwardly into the confines of tubular shell **252** Screws **263** are threadedly mounted in tapped transverse passages defined in flange **222** and when tightened engage recessed portion **250** to removably lock plug C-**1** in passage **232**. A bonnet **258** is removably secured to flange **222** by bolts **260**, with the bonnet having an upwardly extending cavity **262** into which extension **248** projects.

The lower external portion of plug C-**1** and upper external portion of second cartridge **230** are slightly recessed and cooperate to define a circumferentially extending space **282** with the sidewall defining first passage **232**.. Space **282** is in communication with a small diameter lateral passage **284** formed in body **210**. A normally closed small, hand operated valve **286** is mounted on body **210** and in communication with passage **284**. By opening valve **286** it may be determined whether high pressure gas from the well is leaking upwardly past the sealing rings **227** to enter space **282** and exert upward pressure on plug C-**1**. A sealing ring **288** is situated between bonnet **258** and flange **222**. Connector **284** has external threads **234**a defined thereon.

The diversionary spool assembly A-**2** is used by first shutting down the well and then moving first cartridge **226** out of engagement with second cartridge **230**. Bonnet **258** is removed from flange **222**, and screws **263** are then loosened, and threaded extension **248** is engaged by a suitable tool (not shown), with plug C-**1** then being lifted out of first passage **232**.

Threaded extension **256** is now engaged by a suitable tool (not shown), and second cartridge **230**, connector **234**, and a portion of cable **236** lifted above body **210** .If the cable supports a submersible pump (not shown) the latter will be moved upwardly with the cable. When the tubing string (not shown)has bveen closed, the anchor flange (not shown) of the christmans tree array of valves is removably secured to flange **222** by bolts **260** to permit remedial and maintenance to be performed on the well.

When the work is completed, the above described sequence of steps is reversed, and the well placed in operation. Body **210** is removably secured to to casing head S-**1** by bolts **292**. Bolts **294** secure valve **274** to body **210**. A sealing ring **212** is disposed between body **210** and casing head S-**1**.

A third form of diversionary spool assembly is shown in FIG. **3** that is adapted to supply electric power for down hole use, and is capable of having a present day, conventional christmas tree array of valves removably mounted thereon for remedial and maintenance purposes. The third form A-**3** includes a generally cylindrical body **300** that by bolts **302** is removably secured to a casing head S-**2**, which casing head supports a tubing hanger **304**. The tubing hanger **304** has a fluid conducting bore **306** therein from which a tubular fluid conductor **308** extends upwardly to removably engage the lower portion **310** of a first vertical passage **312** that extends upwardly in body **300**.

First passage **312** extends upwardly through a tubular neck **314** that has a flange **316** on the upper end thereof that is a companion flange to the anchor flange (not shown) on a present day christmas tree array of valves. Flange **316** supports a sealing ring **318** that is in abutting contact with a bonnet **320**. The bonnet **320** is secured to flange by bolts **322**.. When the bonnet is removed from bolts **322**, the bolts are used to removably secure the anchor flange to the flange **316**.

A second passage **324** is defined in body **300**, which second passage is laterally disposed and in communication with first passage **312**. A valve **326** is removably secured to body **300** by bolts **328** and in fluid communication with second passage **324**

A plug P is removably mounted in the upper portion of first passage **312** within tubular neck **314**. Plug P includes a lower neck **314**. Plug P includes a lower portion **330** that has a stem **332** projecting upwardly therefrom that supports an enlarged head **334**. Head **334** is slidably movable in an elongate vertical space **336** in an upper plug portion **338**, and is prevented from mov-

ing downwardly out of space **336** by a stop **340** that forms a part of upper plug poprtion **338**.

Lower plug portion **330** and upper portion **338** have adjacent oppositely disposed tapered surfaces **330***a* and **338***a*. Lower plug portion **330** rests on a shoulder **342** defined in first passage **312**. A radially expandable metal band **344** is situated between lower and upper portions **330** and **338** that is expanded into a metal to metal seal with the portion of body **300** that defines first passage **312** when upper portion **338** is moved downwardly and tapered surfaces **330***a* and **338***a* are forced into the interior of the band.

Upper plug portion **338** includes a circumferentially extending recessed portion **348** that is transversely aligned with screws **350** threadedoly supported in flange **316**. When the plug portion **338** is moved downwardly suffeciently to expand band **346** into the previously identified metal to metal seal, the screws **350** are rotated to move inwardly to engage the recessed portion **348**, and lock the plug P in a sealing position in first passage **312**.

The upper plug portion **338** has threads **352** thereon above recessed portion **348**, which threads are used to retrieve plug P from first passage **312** with a suitable tool (not shown) after bonnet **320** is removed from the neck **314** and screws **350** are disengaged from recessed portion **348**.

Lower plug portion **320** and upper plug portion **338** support sealing rings **354** and **354** that sealingly engage the material that defines first passage **312** in tubular neck **314**. Tubular conductor **308** supports upper and lower sealing rings **358** and **360** that engage body **300** and tubing hanger **304**.

Electric power for down hole purposes is supplied through body **300** by an electrical conducting unit U that is illustrated and described in detail in my co-pending application Ser. No. 666,291, filed Oct. 29, 1984, entitled "Top Entry Electrical Transmission Assembly for Submersible Pump".

The unit U includes an electric power supply cable **362** that is connected to a first cartridge **364** that extends downwardly in a bore **366** in body **300**, which bore contains an intermediate cartridge **368** that is removably engaged by the first cartridge. A second electrical conducting cartridge **370** extends upwardly from tubing hanger **304** and removably engages the intermediate cartridge **368**. First cartridge **364** has a plate **372** secured thereto which by bolts **374** is removably affixed to body **300**. Similarly, second cartridge **370** has a plate **376** affixed thereto which by bolts **378** is secured to tubing hanger **304**. Second cartridge **370** is in electrical communication with a cartridge **380** supported in tubing hanger **304**.

Should the metal to metal seal fail, a sealing compound (not shown) may be injected into the space between the upper and lower plug portions **338** and **330** through a normally closed tube **382**. A sealing ring **384** is disposed between body **300** and casing head S-2

By loosening the screws **350** and removing bolts **322** and bonnet **320**, the threads **352** may be engaged by a suitable tool(not shown), and the plug P removed. The anchor flange (not shown) of a conventional present day christmas tree array of valves may now be mounted on flange **316**. The anchor flange is removably secured to flange **316** by bolts **322** to permit remedial and maintenance work to be performed on the well.

A diversionary spool assembly A-**4** is shown in FIG. **4** for use on a dual injection or dual production well. The assembly A-**4** includes a generally cylindrical body **400** that by bolts **402** is secured to a casing head S-**4** as shown in FIG. **4**, with the body and casing head having a sealing ring **404** disposed therebetween. Body **400** includes an upwardly extending portion **406**.

Casing head S-**4** supports a tubing hanger **408** that has a pair of laterally spaced, vertically extending bores **410** therein that are engaged by a pair of vertical, upwardly extending fluid conducting members **412**. The tubular members **412** sealingly and removably engage upwardly extending recesses **414** in body **400** from which a pair of fluid passages **416** extend upwardly through the body and upper portion **406**.

A pair of lateral second passages **418** are defined in body **400** in fluid communication withthe first passages **416** a pair of valves **420** are secured to body **400** by bolts **422**, and are in fluid communication with second passages **418**.

A pair of plugs P of the structure described in detail with reference to the third form A-**3** are disposed in the upper portions of the pair of first passages **416**, and removably held in place therein by screws **424**. The threads **352** on plug P are disposed in a pair of cavities **426** that extend upwardly in a pair of bonnets **428** that are removably secured to upper body portion **406** by bolts **430**.

Each bonnet has a vertical bore **432** therein in communication with a cavity **426**, as well as a small valve **434** that is normally closed. By opening a valve **434** a determination may be made as to whether high pressure gas is leaking upwardly past one of the plugs P. Should a leak be found, a sealing compound (not shown) may be injected through either of two normally closed tubes **436** to seal the leaking plug P.

When the appropriate screw **424** and bolts **430** are removed one of the bonnets **428** may be separated from upper body portion **406** and a plug P removed, to permit an anchor flange (not shown) of a christmas tree array of valves (not shown) to be removably mounted on the upper body portion **406** by use of bolts **430**.

When the christmas tree array of valves is so mounted maintenance and remedial work may be performed on the well..When maintenance and remedial work is not being performed on the well, the diversionary spool assembly A-**4** is used to produce fluid from a well in a customary present day method that is well understood in oil field operation and need not be explained.

A fifth form of diversionary spool assembly A-**5** is shown in FIG. **5** for use on an artesian well and that includes a first flange **500** in which a circle of bolt holes **502** is defined, and through which bolt holes bolts (not shown) may be extended to secure the first flange to casing head (not shown). First flange **500** has a centered bore **504** therein that on the lower end develops into an enlarged portion **506** that is slidably and sealingly engaged by a tubular fluid conductor (not shown) that is of the structure of conductor **412** shown in FIG. **4**.

Fifth form of diversionary spool assembly A-**5** includes an elongate, vertical, generally cylindrical body **508** that has a downwardly extending tubular neck **510** that develops into a second flange **512** that is removably affixed to first flange **500** by bolts **514**. A first passage **516** extends upwardly in body **508** and is vertically aligned with bore **504**.

A plug P of the structure and operation previously described is removably and sealingly mounted in first passage **516**, and has the lower portion thereof of abut-

ting contact with a shoulder **517**. Plug P is removably held in a metal to metal sealing position by screws **518** that are rotatably supported by body **508**. A bonnet **520** is removably secured to the upper end of body **508** by bolts **522**, with the bonnet having a centered vertical bore **524** therein that is in communication with a normally closed, small, hand operated valve **526**. By opening valve **526** a determination may be made as to whether high pressure gas from a well is leaking upwardly in first pasage **516** past plug P. A pair of lateral, small diameter bores **528** are formed in body **508** that are normally closed by threaded caps **530**. By removing caps **530** sealing fluid (not shown) can be injected into first passage **516** to seal with plug P should the latter found to be leaking. Fluid flows upwardly from the well through first passage **516** and then through a lateral second passage **532** to enter a pipe **536** that directs the fluid to a desired destination.

By removing bonnet **520** a present day christmas tree array of valves (not shown) may be secured to the upper end of body **508** by use of bolts **522** for maintenance and remedial work to be performed on the well after plug P has been removed from the first passage **516**. Sealing rings **540** and **542** are disposed between bonnet **520** and body **506** and between second flange **512** and first flange **500**.

A sixth form A-6 of a diversionary spool assembly A-6 is shown in FIG. **6** for use on an artesian well, which third form is of substantially the same structure as the third form A-3, other than the sixth form does not include electrical conducting means. Parts of the third form of assembly A-6 that are common to the third form A-3 are identified by the same numerals previously used but with primes being added thereto.

Bonnet **320'** has a centered bore **600** therein that is in communication with first passage **312'** above plug P'. A small normally closed valve **602** is in communication with bore **600**. By opening valve **602** a determination may be made as to whether high pressure gas is leaking upwardly in first passage **312'** past plug P. If such leakage is occurring screws **382'** are removed and a sealing compound (not shown) injected through lateral passages **604** to seal with plug P'. Body **300'** and casing head S-2' have a sealing ring **606** disposed therebetween, and such a sealing ring is also used on the third form A-3 of the assembly. The sixth form A-6 is used in the same manner as third form A-3 and serves the same purpose other than that the sixth form cannot supply down hole electric power.

The seventh form of diversionary spool assembly shown in FIG. **7** is similar to the fifth form A-5. Parts of the seventh form A-7 that are common to the fifth form A-5 are identified by the same numerals previously used but with primes being added thereto.

Flange **512'** is by bolts **514'** secured to the top of a tubing hanger **700** that is supported in a casing head. A tubular neck **702** extends outwardly from body **508'** and through which passage **532'** extends. Tubular neck **702** has a second flange **704** on the outer end thereof, which flange by bolts **706** is secured to a flange **708** of a valve **710** that is but partially shown..

The upper portion of first passage **516'** has threads **712** formed in the portion of body **508'** that defines the sidewall of the passage. The upper portion **356'** of plug P' has threads **714** defined thereon which when the upper portion is rotated in an appropriate direction move the upper portion downwardly to effect a metal to metal seal as previously described.. When bonnet **520'** is removed a J slot **714** may be removably engaged by a suitable tool (not shown) to rotate upper plug portion **356**, as well as lift plug P' from first passage **516'** when threads **712** and **714** are disengaged. Tubing hanger **700** has an upwardly extending passage **718** therein that includes an upper enlarged portion **720** that is sealingly engaged by resilient sealing rings **722** on a tubular fluid conductor **724** that extends upwardly into an enlarged cylindrical portion **726** defined in body **508'** that is in communication with passage **516'** and in vertical alignment therewith.

Fluid conductor **724** has resilient sealing rings **728** thereon that seal with cylindrical portion **726**. The seventh form of assembly A-7 operates in substantially the same manner as in the fifth form A-5 and serves the same purpose.

An eighth form of diversionary spool assembly A-8 is shown in FIGS. **8** and **9** which is used on a hydraulically operated well.. Eighth form A-8 includes a generally cylindrical body **800** that by a clamp **802** is secured to a casing head **804** that supports a tubing hanger **806**. A sealing ring **808** is disposed between body **800** and casing head **804**. Body **800** has a cylindrical side surface **810**.

Eighth form A-8 includes a power fluid inlet valve **812**, power fluid return valve **814**, and fluid production control valve **816**, which valves include flanges **812***a*, **814***a*, and **816***a*. Bolts **812***b*, **814***b*, and **816***b* removably secure flanges **812***a*, **814***a*, and **816***a* to body **800**. First valve **812** is in communication with a first lateral passage **818** that communicates with a first vertical passage **820** that extends from the bottom **800***a* to the top **800***b* of body **800**. First vertical passage **820** has a lower cylindrical portion **820***a* of increased diameter that is sealingly engaged by a tubular fluid conductor **822** that is mounted in tubing hanger **806** and in communication with a tubing string (not shown) that extends downwardly therefrom. Power fluid discharged under pressure into first passage **820** is returned through a second passage **824** and second lateral passage **826** to second valve **814** for recirculation.

Production fluid flows upwardly through a passage (not shown) in tubing hanger **806** and through a tubular fluid conductor **828** that removably and sealingly engages a cylindrical recess **830** that extends upwardly from bottom **800***a* to communmicate with a third vertical passage **832**. Third passage **832** is in communication with a lateral passage **834** that leads to valve **816**.

In normal operation a bonnet (not shown) will be secured to top **800***b* by bolts to close the upper end of first passage **820**. When maintenance or remedial work is to be performed on the well, the well is shut down, the bonnet removed, and a conventional present day christmas tree array of valves (partially shown) that includes an anchor flange **840** removably secured to body **800** by bolts **836**. Maintenance and remedial work may now be carried out on the well, with access to the well being through first passage **820**. When the work is completed the bonnet (not shown) is caused to replace anchor flange **840**, with the bonnet secured to body **800** by bolts **806**.

The use and operation of the different forms of diversionary spool assemblies has been described previously in detail and need not be repeated.

I claim:

1. In combination with an oil and gas well that includes a casing head from which a string of tubing extends downwardly in a bore hole to a fluid producing

zone, a diversionary spool assembly situated in a fixed position relative said well head to control fluid flow from said well and also serve as a temporary mounting for a Christmas tree array of valves when maintenance work is to be performed on said well, said array of valves including an anchor flange on a lower end thereof, said diversionary spool assembly including;

a. a rigid body mounted on said well head, said body having a top surface, and a plurality of passages therein, a first of said passages extending upwardly through said body and vertically aligned with said tubing string, said first passage having an upper end portion, and a second passage through which fluid flows;

b. valve means for controlling the flow of fluid through said second passage;

c, a plug removably and sealingly mounted in said upper end portion, said plug including an upper engageable portion;

d. first movable means on said body for removably engaging said plug to maintain said plug at a fixed position in said first passage;

e. a bonnet mounted on said top surface of said body that seals said upper end portion of said first passage; and,

f. second means for removably securing said bonnet to said body that is also capable of securing said anchor flange of said christmans tree array of valves to said body after said bonnet is removed from the latter, said spool assembly when mounted on said well head capable of having oil and gas produced from said well, and said spool assembly permitting access to said well through said tubing string for maintenance work to be performed on said well by removing said bonnet from said body and thereafter securing said anchor flange of said array of valves to said body by said second means, moving said first means to disengage from said plug, engaging said engageable portion of said plug and moving said plug upwardly and outwardly from said first passage through said array of valves, performing the maintenance work, and thereafter reversing the above described procedure to return the diversionary spool assembly to an oil and gas producing condition.

2. A diversionary spool assembly as defined in claim **1** in which said oil and gas well includes an electrically driven pump disposed therein below said diversionary spool and in fluid communication with said tubing string, said diversionary spool assembly further including;

g. electrical conducting means at least partially disposed within said body, said electrical conducting means including an electric power receiving portion and an electric power supply portion;

h. electric power means at least partially external of said body that removably engage said electric power receiving portion; and

i. elongate electrical power transmitting means that engage said electric power supply portion and extend downwardly in said well to said electrically operated pump to energize the latter to discharge fluid upwardly through said tubing string and outwardly through said second passage.

3. A diversionary spool assembly as defined in claim **2** in which said electrical conducting means extends vertically through said body and tubing hanger, with said electric power receiving portion disposed above said body and said electric power supplying portion in electrical communication with said elongate electrical power transmitting means.

4. A diversionary spool assembly as defined in claim **1** in which said electric power means includes a first electrical conducting cartridge disposed in a lateral bore in said body and said electrical conducting means is a second electrical conducting cartridge disposed in said first passage, said second electrical conducting cartridge including an electrical power receiving portion and an electrical power supplying portion, with said first electrical conducting cartridge removably engaging said electric power receiving portion of said second cartridge, and said electric power supplying portion of said second cartridge in electrical communication with said elongate electrical power transmitting means.

5. A diversionary spool assembly as defined in claim **4** which in addition includes:

k. a connector secured to said elongate electrical power transmitting means that removably engages said electrical power supplying portion.

6. A diversionary spool assembly as defined in claim **4** which in addition includes:

k. sealing means on aid first electrical conducting cartridge that seal with said body to prevent entry of moisture from the ambient atmosphere through said lateral bore to said second electrical conducting cartridge to do possible damage thereto.

7. A diversionary spool assembly as defined in claim **5** which in addition includes:

l. sealing means on said connector that seal with said second electrical conducting cartridge to prevent gas and moisture from said well contacting said second electrical conducting cartridge to do possible damage thereto.

8. A diversionary spool assembly as defined in claim **1** in which said oil and gas well includes a hydraulically operated pump that is in communication with said tubing string and receives power fluid from said first passage, said second passage having well fluid discharged from said pump flow therethrough, and a third passage in said body through which power fluid discharged from said pump flows.

9. A diversionary spool assembly as defined in claim **1** in which said second passage is in communication with said first passage below said plug.

10. A diversionary spool assembly as defined in claim **1** in which said first passage has an intermediate positioned body shoulder therein, and said plug includes;

g. a lower portion in said first passage seated on said body shoulder;

h, an upper portion in said first passage and longitudinally movable relative thereto;

i. a ring shaped metal seal disposed between said upper and lower portions that is radially expandable into sealing contact with the portion of said body defining said first passage when said first portion is moved downwardly a predetermined distance in said first passage; and

j. third means for removably holding said first portion in a fixed position relative said body after it has been moved downwardly said predetermined distance.

11. A diversionary spool assembly as defined in claim **1** in which said second means is a bonnet, and said third means are a plurality of bolts capable of removably securing either said bonnet or said anchor flange to said

body to dispose said christmas tree array of valves above said body.

12. A diversionary spool assembly as defined in claim **1** in which said oil and gas well is either a dual production or dual injection well, and said diversionary spool assembly in addition including; a second tubular neck; second flange; second plug; second first means; and a second set of first and second passages that are arranged the same on said body as said first tubular neck, first flange, first plug; first means; and said first and second passages as described in claim **18**.

13. In combination with a christmas tree array of valves that includes an anchor flange for supporting it in an upright position, a casing head, a tubing hanger operatively associated with said casing head, a tubing string that extends downwardly in an oil and gas well from said tubing hanger and in vertical alignment with a vertical bore in the latter, a diversionary spool assembly removably disposed in a fixed position above said casing head to control the flow of fluid from said well and to permit remedial and maintenance work to be performed on said well when said christmas tree array of valves is removably mounted on said diversionary spool assembly in vertical alignment with said bore, said diversionary spool assembly including;

a. a rigid body that has a top, bottom and sidewall, a first tubular neck that extends upwardly from said top, a first flange mounted on the upper extremity of said first tubular neck, which first flange is a companion flange to said anchor flange, and a plurality of passages in said body, with a first of said passages extending upwardly in vertical alignment with said body and first tubular neck and in communication with a second passage in said body that has a fluid inlet in communication with said first passage and a fluid outlet in said side of said body;

b. first means for supporting said body above said casing head, with said first passage in communication with said bore in said tubing hanger;

c. a first bonnet removably and sealingly mounted on said first flange;

d. a first plug sealingly and removably mounted in said first tubular neck below said first flange;

e first engageable means on said first plug for retrieving the latter;

f first movable means on said first tubular member for removably engaging said first plug to maintain said first plug at a fixed position in said first passage;

g first valve means for controlling the flow of fluid from said second passage; and

h first second means for removably securing said first bonnet to said body that is also capable of securing said anchor flange of said Christmans tree array of valves to said body after said bonnet is removed from the latter, said spool assembly when mounted on said well head capable of having oil and gas produced from said well, and said spool assembly permitting access to said well through said tubing string for maintenance work to be performed on said well by removing said first bonnet from said body and thereafter securing said anchor flange of said array of valves to said body by said second means, moving said first means to disengage from said plug, engaging said engageable portion of said first plug and moving said first plug upwardly and outwardly from said first passage through said array of valves, performing said maintenance work, and thereafter reversing the above described procedure to return the diversionary spool assembly to an oil and gas producing condition.

14. A a diversionary spool assembly as defined in claim **13** which in addition includes a second set of elements that are duplicates of said first and second passages in said body, said first tubular neck, said first flange on said first tubular neck said first plug in said first tubular neck, said first bonnet removably and sealingly mounted on said first flange, said first means, and said second means for removably securing said first bonnet to said first flange as set forth in claim **14** to permit said diversionary spool assembly to be used on either a dual injection or dual production oil and gas well.

15. A diversionary spool assembly as defined in claim **13** which in addition includes;

i. third means for determining whether pressurized gas from said well has leaked upwardly past said plug in said first tubular neck.

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